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Comparison between YCbCr Color Space and CIELab Color Space for Skin Color Segmentation

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ABSTRACT
Skin color is a simple but powerful pixel based feature. Skin color has proven to be a useful and sturdy cue for face detection, localization and tracking, hand detection, etc. Skin color is a useful means for human face detection. In this paper, we propose two color spaces YCbCr and CIELab and compare the results of both color space. Analyze the efficient method for skin color segmentation under varying lighting conditions. Experimental results show that CIELab color space is better than other color space. It can improve the performance of face segmentation under poor or strong lighting conditions.

Keywords
YCbCr color space, CIELab Color Space, Skin Color Segmentation, Morphological Operation

1. INTRODUCTION
Skin color is good feature for detection the human face. Color allows fast processing [1] .Skin color has proved to be useful and sturdy cue for face detection, localization and tracking. It is useful in human computer interaction (HCI), human face recognition system and vision based gesture recognition [2, 3].Skin color segmentation becomes sturdy if chrominance component used for segmentation. The method is choosing which eliminate the variation in luminance component. Skin color detection faces many problems like different cameras produces different color values even for same person under same light conditioning. The luminance component has more variation which is most important problem among current skin detection system that seriously degrades the performance. The color space choose for skin color segmentation determine the how efficiently skin color space method detect the skin color. Skin color differs from person to person. A disadvantage of color cue is its sensitivity to illumination color change especially in RGB color space. One way to overcome this problem is change the image means transform RGB image into other color space whose intensity and chrominance are separated. Among the YCbCr and CIELab color spaces both are good.YCbCr color space is also good for skin color segmentation.YCbCr color space are used by Shuying Zhao and Furkan Isikdogan[4,5].YCbCr color spaces also used by Junho An for finger's segmentation for playing the game in mobile[6]. In this paper, we proposed a comparison of two skin color detection algorithm based on YCbCr and CIELab color spaces. Result of comparison shows that YCbCr has some problems to detecting some skin color. CIELab color space has main advantage is that it is device independent. The results show that proposed CIELab algorithm is more effective to detect the skin color than other color spaces.

The goal of this paper is to compare the detection results obtained with YCbCr and CIELab color spaces. Section 2 is devoted to description of different color spaces that are RGB, YCbCr and CIELab used for skin detection. Section 3 describes the proposed YCbCr and CIELab color spaces algorithm. Section 4 describes the results of proposed algorithm and section 5 describes the comparison of proposed methods.

2. COLOR SPACES USED FOR SKIN MODELING
Skin color segmentation is used to determine whether the color pixel is a skin color or non skin color. Good skin color segmentation is that which segment the every skin color whether it is blackish, yellowish, brownish, whitish and give good results under different light conditioning as possible[4,5,6]. There are different color spaces have been used for color classification is done by using chrominance component because it is expected that skin color segmentation may become more sturdy to lighting variations if luminance component is discarded. In this paper, YCbCr and CIELab algorithm are used for skin color segmentation and the results are compared. In this section the three well known color spaces RGB, YCbCr and CIELab are described.

2.1. RGB
RGB is additive in nature. It is sum of three primary colors red, green and blue. Any other color space can be obtained from a linear or non-linear transformation from RGB. RGB is one of most widely used color space for processing and storing the digital image data [7].However, high correlation between the red, green and blue colors. This color space is device dependent it means that the same signal or image can look different on different devices. This is main disadvantage of this color space. In RGB chrominance and luminance component are mixed that is why RGB is not choose for color analysis and color based segmentation algorithm.

2.2 YCbCr
YCbCr color space has been defined in response to increasing demands for digital algorithms in handling video information and has become a widely used model in a digital video. Y is luma component which represent the luminance and computed from nonlinear RGB [1]. It is obtained as weighted sum of RGB values. Cb is difference between blue and luma component and Cr is the difference between red and luma component [7.8]. The Y in YCbCr denotes the luminance component, and Cb and Cr represent the chrominance component.

$$Y = 0.299R+0.587G+0.114B$$
$$Cr = R-Y$$
$$Cb = B-Y$$

In contrast to RGB, the YCbCr color space is luminance independent, that's why it gives better performance. The threshold is used in our algorithm is given as

$$76< Cb <127$$

$$132 < Cr < 173$$

The transformation is simple. Unlike RGB, it has separate luminance and chrominance components which make this color space attractive for skin color segmentation [9].

2.3 CIELab

It is perceptual uniform color space. Perceptual uniformity means how two colors differ to see when human observe that two colors. Hence uniform color spaces were defined in such way that all the colors are arranged by the perceptual difference of the colors [1]. However, the perceptual uniformity in these color spaces is obtained at the expense of heavy computational transformations. In these color spaces, the computation of the luminance (L) and the chroma (ab or uv) is obtained through a non-linear mapping of the XYZ coordinates. CIE (Commission International d'Eclairage) specifies three: CIE*XYZ, CIE*Lab, and CIE*Luv. In CIE*Lab or CIELab, the three component l represent luma component that is illumination information and ab represent the chroma information. L*=0 provide the black color and L*=100 provides white color .The a*, the values a*<0 that indicate green while the values a*>0 indicate magenta. The b*, the values b*<0 that indicate blue and values b*>0 indicate yellow [10].

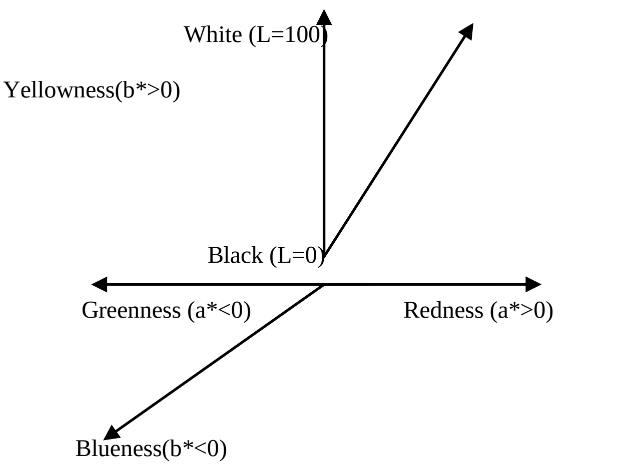


Figure 1: CIELAB Color Model

The Lab color space has been created to serve as a device independent, absolute model to be used as a reference [11, 12]. It is based on the CIE*XYZ color space which can be derived using:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4125 & 0.3576 & 0.1804 \\ 0.2127 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9502 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

$$L = \begin{cases} 116 \left(\frac{Y}{Y_n}\right)^{\frac{1}{3}} - 16 & if \frac{Y}{Y_n} > 0.008856 \\ 903.3 & otherwise \end{cases} \quad (2)$$

$$a = 500 \left[\frac{X^{\frac{1}{3}}}{X_n} - \frac{Y^{\frac{1}{3}}}{Y_n}\right] \quad (3)$$

$$b = 200 \left[\frac{Y^{\frac{1}{3}}}{Y_n} - \frac{Z^{\frac{1}{3}}}{Z_n}\right] \quad (4)$$

3. PROPOSED ALGORITHM FOR SKIN COLOR DETECTION

The input is RGB image which consists of three layers red, green, and blue.

3.1 Conversion from RGB image into YCbCr image

To convert the RGB image into YCbCr image, separate the chroma component Cb and Cr. Y component represent the luminance information which has more variation that is why discard this component, Cb and Cr component are used. Apply the threshold on these components and get binary image. After skin color segmentation by YCbCr color space that contain noise and some imperfection. To improve the image and to remove noise morphological operations are applied on the image and to get further refined image, median filter is applied.

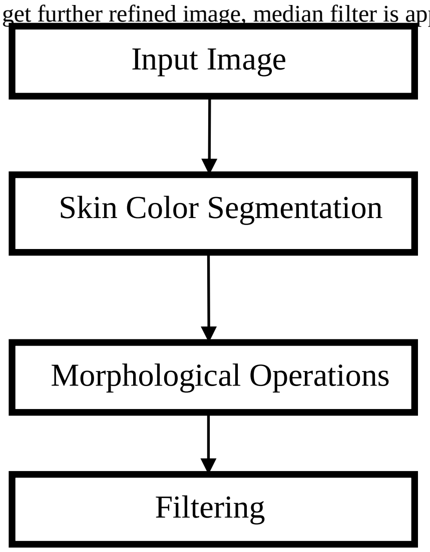


Figure 2: Process Flow Diagram

3.2 Conversion from RGB image into CIELab image

To convert RGB image into CIELab, apply the algorithm and separate the chroma component a and b. In this color space L represent lightness which has more variation that's why this component is discarding. It is based on the CIE*XYZ color space which can be derived using:

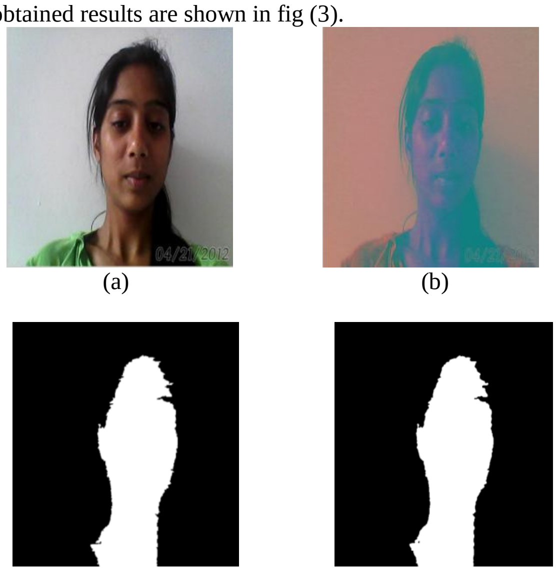
$$a = 500 \left[\frac{B1^{\frac{1}{2}}}{X_n} - \frac{B2^{\frac{1}{2}}}{Y_n}\right] \quad (5)$$

$$b = 200 \left[\frac{B2^{\frac{1}{2}}}{Y_n} - \frac{B3^{\frac{1}{2}}}{Z_n}\right] \quad (6)$$

After getting the binary image apply the morphological operations and filtering process to remove the noise. Refined image is obtained.

4. RESULTS

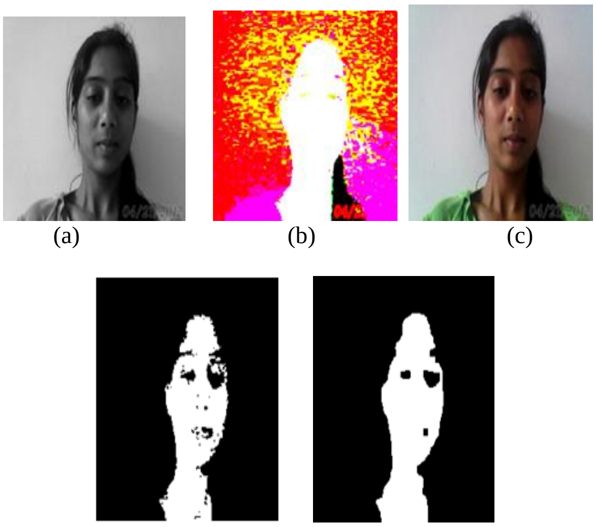
After Skin color segmentation with YCbCr color space in real time, obtained results are shown in fig (3).



(a) (b) (c) (d)

Figure 3: (a) RGB Image (b) YCbCr Image (c) Binary Image (d) After Noise Removal

As shown in fig 3, RGB image is converted into YCbCr color space and binary image is obtained, by applying the morphological operation and median filter, noise is removed and refined image is obtained. After skin color segmentation with CIELab color space in real time,



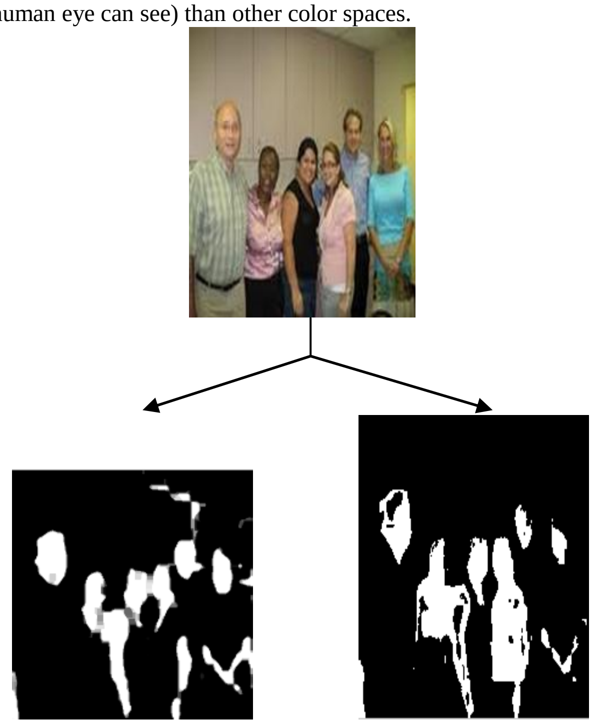
(a) (b) (c) (d) (e)

Figure 4: (a) RGB Image (b) Grayscale Image (c) Skin Detection (d) Binary Image (e)Noise Removal Image

As shown in fig 4, RGB image is converted into gray image. CIELab color space detects the skin color and converted it into binary image. The binary image has some noise, by applying the morphological operation and median filter, noise is removed and refined image is obtained.

5. COMPARISON BETWEEN YCbCr AND CIELab COLOR SPACE

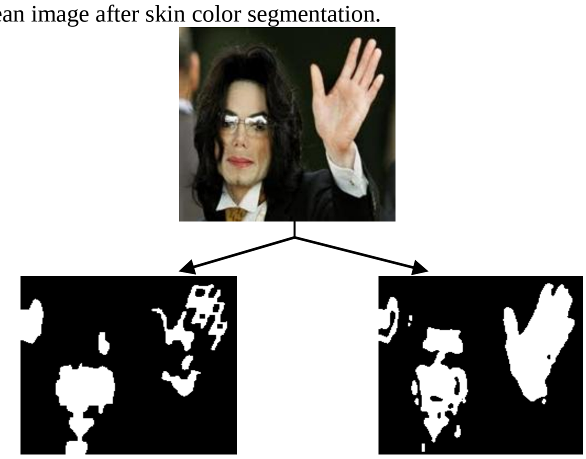
In this section a detailed experimental comparison of the YCbCr and CIELab algorithms has been presented. Comparison of skin color segmentation with two space color model one with YCbCr and other with CIElab shows that fast segmentation is done with CIElab color space. Moreover, the CIELab color space is an absolute color space, it defines colors exactly. It does not depend on input devices (camera) or output devices (monitors and printer). CIELab includes more color (even more than the human eye can see) than other color spaces.



YCbCr CIELab

Figure 5: Skin color segmentation with YCbCr and CIELab Color Space

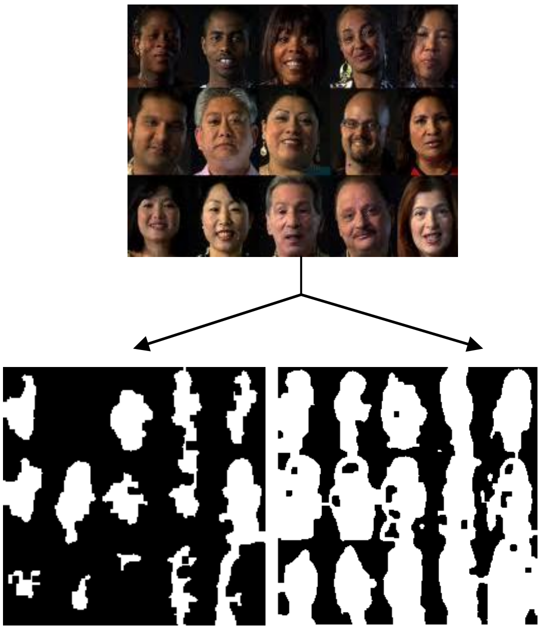
Figure 5 shows the YCbCr color space which gives the blur image after segmentation while with CIELab color space gives clean image after skin color segmentation.



YCbCr CIELab

Figure 6: Skin color segmentation with YCbCr and CIELab Color Space

Figure 6 shows the YCbCr color space does not give proper information of skin after segmentation while CIELab gives the more skin color information.



YCbCr CIELab

Figure 6: Skin Color Segmentation of different faces with YCbCr and CIELab Color Space

Figure 6 shows the segmentation with YCbCr and CIELab color space with different skin color faces. Some faces disappear when YCbCr color space is apply for skin color segmentation while CIELab color space do the proper skin color segmentation and no face disappear by applying CIELab color space.

6. CONCLUSION

CIELab color space is an absolute color space, it defines colors exactly. It does not depend on input devices (camera) or output devices (monitors and printer). CIELab includes more color (even more than the human eye can see) than other color spaces. We observe that segmentation with CIELab color space is better than YCbCr because it gives more information than the other color space model. We face many problems during segmentation due to different light condition and background color. After performing these segmentation methods we conclude that CIELab is good for skin color segmentation.

7. FUTURE WORK

Skin color segmentation is helpful in vision gesture recognition, human computer interaction, face detection, localization and tracking. After the skin color segmentation, feature extraction can be done which will be helpful to make gesture for human computer interaction.

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